

XXXVII.—Note on the Genus *Lithostrotion*.

By WILLIAM LONSDALE, F.G.S.

To the Editors of the Annals of Natural History.

GENTLEMEN,

SHOULD the following memoranda on the genus *Lithostrotion* be deemed admissible, I shall feel obliged by their publication in the 'Annals and Magazine of Natural History.'

I have the honour to be, Gentlemen,

Your most obedient servant,

Melksham, Nov. 1851.

W. LONSDALE.

Lhwyd* is well known to have applied the definition, "*Lithostrotion sive Basaltes minimus striatus et stellatus*," to a coral represented in table 23 of his work on British Fossils; but no farther description of it is given in the chapter on coralline stones or in Letter Five (*op. cit.* p. 122). The rude delineation, just quoted, expresses fully an aggregate of polygonal columns longitudinally striated and transversely rugose; the upper surface presents also closely applied stellated areas variable in size as well as in the number of the facets, but uniformly traversed by many converging, fine rays. The limited amount of information thus communicated renders a satisfactory comparison with other basaltiform and lamelliferous *Zoantharia* hazardous; but Parkinson† identified a Welch coral with Lhwyd's *Lithostrotion*, and he describes it as composed "of polygonal columns, exactly adapted and closely concreted" (p. 43); but detachable from the general mass "by a moderate stroke" applied laterally (p. 44); the facets of the columns are moreover stated "to be finely and closely striated longitudinally, the striæ being intersected by very fine and closely set transverse ridges" (p. 44). Complete apices are also said to be "concave and to have a prominent star, one-third of the diameter of the concavity, arising out of the centre" (p. 44). A longitudinal section is further described as having "a striated plumose appearance" (*l. c.*); and allusion is made to "numerous, exceedingly slender longitudinal lamellæ, corresponding with the external striæ;" also to "equally delicate lamellæ perpendicularly disposed nearly in concentric circles; while others answering to the external transverse ridges," are stated to pass horizontally through both of the perpendicular sets (p. 44). Parkinson gives therefore a considerable amount

* *Lithophylacii Britannici Ichnographia*, edit. 1699.† *Organic Remains of a Former World*, vol. ii. p. 43-44, pl. 5. figs. 3 and 6, 1808, reprinted 1833.

of detailed information, omitting among essentials simply the mode of developing additional corallites or columns. His figures and description, however, can be compared with Lhwyd's delineation only as regards the mode of aggregation, the form and exterior characters of the columns, and the many rays. It is also probable that Lhwyd's fossil possessed equally with that of Parkinson a facility in breaking into small masses or single corallites; but whether the original *Lithostrotion* had an internal structure similar to that of the coral identified with it, must be a conjecture. Following the literature of the genus as accurately as possible, the next authority, accompanied by a description*, which can be quoted is Dr. Fleming†, and he is believed to be the first naturalist who assigned a place to *Lithostrotion* in a system of zoology. He describes four species: 1. *L. striatum*; 2. *L. floriforme*; 3. *L. oblongum*; and 4. *L. marginatum*. The first is identified with Lhwyd and Parkinson's delineations; but "the rays of the star" are stated to "unite with a small, solid, central axis" (*op. cit.* p. 508); the second species, *L. floriforme*, is founded on the Derbyshire fossil represented by Martin‡, and designated *Erismatolithus Madreporites (floriformis)*; and it is said by Dr. Fleming "to differ chiefly from *L. striatum* in its greater size, and the axis occupying a greater space;" he quotes also the following statement of Martin—"centres projecting, pointed and writhed or twisted like a rope §." The third species, *L. oblongum*, is the well-known oolitic Tisbury coral, figured by Parkinson||, whose delineations are cited; and the fourth, *L. marginatum*, is a mountain limestone fossil of which Dr. Fleming had seen only "two detached columns" (p. 508). The present inquiry is necessarily limited to the first two species.

* In the 'Outlines of the Geology of England and Wales,' by the Rev. W. D. Conybeare and Mr. W. Phillips, Lhwyd's figure is quoted under the designation *Astrea basaltiformis* (p. 359, 1822), but no description or reason for a changed generic determination is given.

† History of British Animals, p. 508, 1828.

‡ Petrificata Derbiensia, tab. 43. figs. 3 & 4; also tab. 44. fig. 5? 1809.

§ The Derbyshire fossil figured by Guettard is probably this species, and the peculiar detached flower-like character of the terminations to the corallites is stated in an extract from a catalogue to be due to the decomposition of the cellular tissue—"la plupart sont évidés par la décomposition de leur tissu cellulaire, ce qui les rend semblables à des fleurs en entonnoir, garnies de leur pistil." (Mémoires, &c. t. iv. of the complete series, or t. i. Nouvelle Collection, p. 75. pl. 30, 1786.)

|| Org. Rem. t. ii. p. 56. tab. 6. figs. 12, 13. The fossil has been recently named *Isastrea oblonga* by M. Milne-Edwards and M. J. Haime, Archives du Mus. d'Hist. Nat. vol. v. p. 103, 1851; also volume of the Palæontographical Society for 1851, Description of British Fossil Corals, Part 2. p. 73-75.

Lithostroton was regarded by De Blainville* as only a section (A) of *Columnaria*, characterized by "cellules avec un axe solide au centre des rayons;" and he included in it *Lith. (Column.) striatum* as well as *L. (Col.) floriforme*, referring in the former species to Fleming, Lhwyd, and Parkinson; and in the latter to Martin. The next authority, known to the compiler of this notice, is Mr. J. Phillips†, who represents and describes a Yorkshire and Welch coral under the term *Cyathophyllum basaltiforme*; and he identifies it with the *L. striatum* of Parkinson and Fleming. It is stated to be composed of adherent prismatic or pyramidal tubes, striated longitudinally and undulated transversely; to have thirty-six to fifty lamellæ, "the marginal lamellæ commencing within a thin crenulated vertical dissepiment." No mention is made of an axis great or little; on the contrary, an enlarged, transverse section (fig. 22) exhibits a direct centre of twisted lamellæ—a structure opposed to Dr. Fleming's "small, solid, central axis;" and nothing like Parkinson's "prominent star, one-third of the diameter of the (terminal) concavity arising out of its centre" (Org. Rem. ii. 44), is expressed in what appear to be tolerably preserved centres (Geol. Yorks. tab. 2. f. 21). Lieut.-Col. Portlock, in his 'Report on the Geology of the County of Londonderry,' &c. (1843), notices a carboniferous fossil to which is applied the designation *Astrea basaltiformis* (p. 333), and it is considered equivalent to *Cyath. basaltiforme* (Phillips), *Columnaria sulcata* (Goldfuss), and *Lithostr. striatum* (Fleming). The "mass" of which a specimen consists is stated to be readily fractured; and the long, slightly undulating prismatic tubes, resembling basaltic columns in miniature, are transversely undulated and longitudinally striated (*op. cit.* p. 333), and under *Ast. hexagona* it is said to have a conical, twisted umbo (p. 332). Prof. M'Coy also includes in Mr. Griffith's‡ work on the Carboniferous Fossils of Ireland *Lithostr. striatum* (Parkinson), citing *Cyath. basaltiforme* of Mr. Phillips, whose characters are nearly adopted. The above particulars have been given to show that among the mountain limestone Zoantharia of England, three composed of basaltiform columns had been described by Parkinson, Dr. Fleming, and Mr. J. Phillips previously to 1845, but each so far as known distinguished by peculiarities of structure; and it is believed that a due consideration of their detailed characters will raise a doubt, whether any one of them can be truly referred to

* Manuel d'Actinologie, p. 350, Atlas, pl. 52. fig. 3, 1830-34; see also Lamarck's Anim. s. Vert. ed. 1836, t. ii. p. 343.

† Illustrations of the Geology of Yorkshire, Part 2. p. 202. pl. 2. figs. 21, 22, 1836.

‡ A Synopsis of the Characters of the Carboniferous Limestone Fossils of Ireland, p. 188, 1844. Printed for private distribution.

Lhwyd's fossil, though all three have been identified with it. A similar impression induced the author of this notice, when he described the corals collected by Sir R. I. Murchison in Russia in Europe and the Ural Mountains*, to state that Lhwyd's coral "has probably been mistaken in some cases for other fossils of similar general aspect, yet of very different structure;" and as a subdivision of Dr. Fleming's genus appeared necessary, he adopted as the type of *Lithostrotion* that authority's second species, being "a well-known, strongly marked coral, and excellently figured by Martin in his 'Petrificata Derbiensia'" (*op. cit.* p. 603). In a subsequent portion of that Appendix (p. 619), the describer applied the term *Stylastrea* to certain corals, which he considered referable to Parkinson's fossil; and if he erred, as he feels he did, in positively identifying, on insufficient data, the latter with Lhwyd's delineation, the admission of the error only leaves still more doubtful the actual nature of that body. In retaining the term *Lithostrotion* for the second species of Dr. Fleming, who it must be remembered really established the genus, and in suggesting a new designation for corals which bear only a certain resemblance to the first species, the author believes he acted in conformity with one of the rules laid down by the Committee of the British Association appointed to prepare "A series of propositions for rendering the nomenclature of zoology uniform and permanent †." According to that rule, "When the evidence as to the original type of a genus is not perfectly clear and indisputable, then the person who first subdivides the genus may affix the original name to any portion of it at his discretion, and no later author has a right to transfer that name to any other part of the original genus" (*op. cit. infra*, p. 264. § 5).

Martin's delineation (Pet. Derb. t. 43. f. 3), though taken from a limited fragment, expresses so completely the general characters of the fossil, that in the examination of a collection of Derbyshire zoophytes no mistake could be made in identifying a specimen, should one occur. The essential characters given in the Appendix before mentioned are—"stems generally coadunated; interior of stems separable into three differently constructed areas: 1. a central axis; 2. an inner zone composed of vertical lamellæ; 3. an outer zone formed partly of lamellæ, but chiefly of variously arched or vesicular plates: the mode of reproduction" is further said to have been "by germs developed within the area of the parent stem, or without it by an occasional extension of the po-

* Geology of Russia in Europe and the Ural Mountains, by Sir R. I. Murchison, M. Ed. de Verneuil, and Count Alex. von Keyserling, vol. i. App. A. p. 602 *et seq.*, 1845.

† Annals and Magazine of Natural History, 1st Series, vol. xi. April 1843, p. 259 *et seq.* See also Report of the British Association for 1842, p. 105

type" (*op. cit.* p. 603). Martin's specimen was silicified (Pet. *Derb. l. c.*), apparently a prevalent mode of mineralization, and less favourable to the exhibition of minor structures than when the process has been effected by carbonate of lime; but his figures 3 and 4 (tab. 43) clearly express a triple composition; and many terminal cavities of the specimens examined displayed no greater amount of detailed composition than is given in those delineations, while others in the same mass exhibited fully the peculiarities of each area. The mode of reproduction is neither represented nor mentioned by Martin; but in a large, siliceous Derbyshire specimen of very irregular growth, obligingly lent to the author by Mr. Wilson of Lydstip House near Tenby, instances were detected of what appeared to be young germs developed within the area of the parent column; also of others based upon the united edges of two closely applied mature terminations; and they plainly could not therefore have sprung either from the side of the old corallites or from an interspace; while some could not be assigned to a definite position with respect to pre-existing stems. It is obvious, that where the growth was very irregular, and the vesicular or outer zone was squeezed into a vertical position or greatly compressed, germs and young columns may appear to occupy anomalous situations; and the difficulty in forming a right inference is increased when transverse sections cannot be consulted. Among the staple productions of the Clifton or Bristol dealers is however one, which possesses all the essential structures of the Derbyshire coral. It is apparently included by Mr. Phillips* under the designation *Cyathophyllum crenulare*; which is regarded as different from *Cyath. floriforme*, the term applied to Martin's fossil; but the distinction is only specific; and it remains to be ascertained, if under equally favourable opportunities for examination, any real variations exist. The Clifton specimens being calcareous are easily cut; and transverse sections containing illustrative examples of the mode of producing young corallites may usually be obtained. In an early state, the germ, situated in the vesicular zone and in general partly in contact with the wall of the parent, presents a small, round, oval or irregular area, defined by an opaque white uneven line; and according to the degree of advancement, rudimentary lamellæ, everywhere equally imperfect, issue from the boundary: an incipient axis is also visible in the centre of the area. In the next stage, a second defining line appears, separated from the former by a narrow band, which is crossed generally by lamellæ, but is sometimes occupied in part by

* *Geol. Yorkshire*, Part 2. p. 202; *C. crenulare* and *C. floriforme*; and for delineations of the former consult pl. 2. figs. 27 & 28.

arched laminae. At first, the line and band are limited to the free side of the young corallite, or that fronting the mature centre, and the line is united at each extremity with the wall of the parent. As however the offspring increased, the portion before stated to be in contact with the pre-existing mature boundary is separated; and an interspace is laid open, perfecting the range of the narrow band; while the second defining line is completed by an upward extension, on that side, of the old wall, or by an equivalent structure. In this state, the first-formed limit constitutes the partition between the lamelliferous and vesicular zones, and the second is the permanent wall of the added corallite. Remarks on further advanced conditions are unnecessary. Among the Russian polyparia before mentioned, four species of *Lithostrotion* are described*, three of which were believed to be new, and one to be identical with the *L. floriforme* of England. They all displayed fully the triple composition of the Derbyshire and Clifton fossils; and the first noticed species exhibited a sufficient number of young corallites within the boundary of the parent to prove that such was the essential mode of reproduction (p. 605); in the third species, *L. astroïdes*, a decided instance was also noticed (p. 608); and in the fourth, *L. floriforme*, cases were likewise believed to have been detected (p. 610); but in the second species, *L. mammillare*, "the young columns projected irregularly above the general surface, and in positions which rendered it difficult to imagine that they could have been in a young state included within the areas of the adjacent mature columns" (p. 607). The foregoing statements will, it is hoped, justify the conclusion drawn in 1845 respecting the prevalent mode of developing additional corallites in the fossils assigned to *Lithostrotion*. Many instances will occur to every collector in which it will be difficult to decide on the real mode; and if only such be accessible, they would lead to a different conclusion from that at which he has arrived. He begs to add, that he does not rest on the reproductive process alone for the establishment of *Lithostrotion* as defined in the Appendix before quoted.

It is now necessary, in order to show still further the uncertainty of the fossil originally termed *Lithostrotion*, to offer a few additional observations on carboniferous basaltiform corals. It has been already stated, that in the work on Russia by Sir R. I. Murchison, M. Ed. de Verneuil, and Count A. von Keyserling

* Count A. von Keyserling has united the four corals under one species, *Lith. floriforme*, but it is hoped that a careful consideration of the detailed characters will justify the original conclusions. He also includes *Stylastrea* in *Lithostrotion*; nevertheless the points of difference, noticed in a paragraph of this communication, are considered sufficient to justify a generic separation. (Reise in das Petschora-Land, pp. 152 & 154, 1846.)

(p. 619), the name *Stylastrea* was proposed for fossils considered as allied to the one described by Parkinson, and the following generic characters were given: "Columnar, lamellæ exceeding twelve; columns closely aggregated, easily separated; internal structure twofold—1st, a central area occupied by variously blended lamellæ or contorted laminæ, without a distinct persistent axis; 2nd, an outer zone, traversed by vertical, continuous, bi-plated lamellæ, not fasciculated; interstices occupied by numerous arched or vesicular laminæ; additional columns produced by subdivisions of the parent column" (*op. cit.* p. 621). The leading points of difference from *Lithostrotion* are a bi-areal instead of a tri-areal composition, and a fissiparous in lieu of a terminal gemmiferous mode of increase; but the subordinate distinctions must not be overlooked in estimating the value of the generic determinations. The agreements with Parkinson's fossil consist in the basaltiform configuration and the external characters of the aggregated columns, in the facility with which they may be separated; also in the plumose appearance of a longitudinal section*, and probably in the nature of the dissepiments between the lamellæ; but Parkinson does not allude to the composition of the centre, except that perfect terminations have a projecting star; leaving doubtful what would be the characters presented by a transverse section; and the comparison is still farther defective in no complete upper extremities of *Stylastrea* having been seen by the author; moreover the mode of increase is neither delineated nor described in the 'Organic Remains' (t. ii. p. 43, 44. tab. 5. figs. 3 & 6). Should the points of agreement be now considered insufficient to warrant a positive identification of any one of the fossils noticed in the remarks on *Stylastrea*† with Parkinson's coral, still they are deemed enough not to justify a decided generic separation. It is nevertheless fully admitted, that an absolute identification of that authority's coral, and consequently of those constituting *Stylastrea*, with Lhwyd's delineation was incorrect, the available points of comparison being too few. It must also be mentioned, that the proposed genus differs from Dr. Fleming's *Lithostrotion striatum* in wanting the "small, solid, central axis" (Brit. Anim. p. 508). Prof. M'Coy‡ has more recently described a new species of *Sty-*

* Parkinson, 'Org. Rem.' vol. ii. p. 44: compare the characters mentioned above with fig. 2 a of *Styl. inconferta*, App. A. pl. A; also with the description in p. 622, 'Geol. Russia,' &c. The Bristol or Welch coral noticed in pp. 619, 620, exhibits also in fractured vertical sections the plumose structure; and it is immaterial whether Parkinson alludes to the surface of separated lamellæ-plates, or to the interlamellæ-dissepiments, each structure when divided having a resemblance to a feather.

† Geol. Russia, &c. vol. i. p. 619.

‡ Annals and Magazine of Natural History, 2nd Series, vol. iii. p. 9. January 1849.

lastrea (*Styl. irregularis*); and he states that it "is remarkable for the nearly perfect transverse chambering of the central area;" a character delineated however to a certain extent in the Russian fossil *Styl. inconferata* (*op. cit.* pl. A. figs. 2, 2 a), but believed not to be persistent. Prof. M'Coy* has further described another carboniferous basaltiform genus, *Stylaxis*, also composed of adjacent, polygonal, easily separable tubes; and it is distinguished by having, "1st, a thin, flat, straight axis; 2nd, a broad inner area composed of numerous curved, vesicular plates in irregular rows converging upwards to the axis; 3rd, an outer area composed of smaller and more curved vesicular plates in rows inclining obliquely upwards and outwards." The mode of increase is likewise fissiparous (*op. cit.* woodcut, p. 119. fig. a). Two species are described, and one of them, *Stylaxis Flemingi*, is regarded by Prof. M'Coy as probably the *Lithostr. striatum* of Dr. Fleming; but he considers that authority to be wrong, in referring to Lhwyd and Parkinson's fossils as specifically identical with that noticed in the 'British Animals.' In the 'Archives du Muséum d'Histoire Naturelle' other species of *Stylaxis* are mentioned, and one of them, *Styl. Portlocki*, is stated to occur in the carboniferous series of Wales (Carbonifère, Galles, p. 453). *Nemaphyllum arachnoideum* of Prof. M'Coy is also transferred to the genus (*op. cit.* t. v. p. 454).

The reader has thus had brought under his attention the following basaltiform corals found in the carboniferous limestone of England, independent of the species of *Stylaxis* mentioned in the 'Archives':—

1. Lhwyd's *Lithostrotion sive Basaltes minimus striatus et stellatus*.

2. Parkinson's Welch fossil, identified by him, but on insufficient evidence, with Lhwyd's *Lithostrotion*.

3. Dr. Fleming's *Lithostr. striatum*, considered by that authority as equivalent to both the preceding fossils, a determination regarded as doubtful.

4. Mr. J. Phillips's *Cyathophyllum basaltiforme*, identified in the 'Geology of Yorkshire' with Parkinson and Fleming, but for the reasons before given believed to be distinct.

5. Prof. M'Coy's *Stylastrea irregularis*.

6. ————— *Stylaxis major*.

7. ————— *Flemingi*, regarded by Mr. M'Coy as possibly the *Lithostr. striatum* of Dr. Fleming.

Each of these fossils possesses the striated and stellated characters mentioned by Lhwyd in his definition, if such it can be considered; each of the latter six might therefore with equal

* Ann. and Mag. Nat. Hist., 2nd Series, vol. iii. p. 119 *et seq.*, February 1849.

propriety be assumed to be the fossil of that authority; and three of them (Nos. 2, 3 and 4) have been so identified. It would nevertheless, in the present state of knowledge, and the demand for detailed information, be altogether unjustifiable to refer any one of the series positively to Lhwyd's coral; and the author conceives that the subsequent investigations have fully supported the doubts which he entertained, when the Russian collection was under examination, as well as the correctness of the generic determinations then proposed.

In resuming the observations on *Lithostrotion*, it is necessary to state, that Prof. M'Coy in January 1849* considered the genus, as defined by the compiler of these memoranda, to be equivalent to the *Strombodes* of Schweigger †, adopting that naturalist's first division of the genus (*Coni e centro proliferi*) as its limits. It is not known whether the opinion is maintained; nevertheless should it be, the author feels assured that a reconsideration of the subject will afford grounds for doubting whether the known structures of *Lithostrotion* can exist in Foug's ‡ *Madrepora composita*, confining the attention to figure 11 and diagram no. 4, to which alone Schweigger refers. The next known notice of *Lithostrotion* occurs in the Introduction to M. Milne-Edwards and M. Jules Haime's § first memoir on 'British Fossil Corals' (*op. cit. infra*, p. lxxii.). The genus is stated to consist of the *Lithostrotion* of Fleming in part; and the characters expressly mentioned are—"columella formed by a fasciculus of twisted bands, and the septa" (lamellæ) "subvesicular exteriorly and joining the columella along their inner edge." *Lith. floriforme* of Fleming is also given as the "typical species; but it is not known to what genus *Lith. striatum* was referred when the 'Introduction' was written. In the portions of volume v. of the 'Archives du Muséum d'Histoire Naturelle' published during the present year (1851) is a "Monographie des Poly-piers Fossiles des Terrains Palæozoïques," also by M. Milne-Edwards and M. J. Haime; but *Lithostrotion* has different generic characters assigned to it; and in the General *Classification* of corals by which the monograph is preceded (p. 172), *L. striatum*, Fleming, is the "example" whereby the genus may be identified. The following are the generic equivalents and characters given in the body of the work (p. 432):—

Lithostrotion (pars), Fleming; *Lithodendron*, Phillips (non

* Ann. and Mag. Nat. Hist. 2nd Series, vol. iii. p. 10, January 1849.

† Beobachtungen auf Naturhistorischen Reisen. Systematic Table, 6, 1819.

‡ Dissertatio de Coralliis Balticis, 1745, apud Amœnitates Academicas, vol. i. p. 198, illustrative plate, fig. 11, and diagram no. 4.

§ Memoirs of the Palæontographical Society, first volume for 1850.

Schweigger)*; *Axinura*, Castelnau; *Stylastrea*, Lonsdale?; *Columnaria*, Dana (non Goldfuss); *Siphonodendron* et *Nemaphyllum*, M'Coy; *Acrocyathus* et *Lasmocyathus*, D'Orbigny.

“Polypier composé, se multipliant par gemmation latérale. Polypiérites entourés d'une épithèque complète, tantôt restant libres entre eux latéralement, tantôt complètement soudés par leurs murailles. Cloisons assez bien développées. Chambres viscérales présentant dans leurs parties extérieures des traverses vésiculaires, et dans leurs parties centrales des planchers bien développés, qui sont traversés par une columelle styloforme” (p. 432).

The first species described, *Lithostrotion Canadense* (p. 433, also explanation of plates, p. 483, with note¹), is an American coral; but the remarks on the genus contain the accompanying observation:—“Fleming comprend dans ce groupe quatre espèces: la première avait déjà été anciennement nommée par Lhwyd, *Lithostrotion*, et c'est elle qu'on doit considérer comme le type du genre” (p. 432). In the following remarks therefore, those corals which possess the aggregated composition with the known structures of Lhwyd and Fleming's *Lith. striatum* will be regarded as the measure of generic comparison.

Respecting the genera of M. Castelnau and M. D'Orbigny the author can offer no remarks, not being able to consult their works; but *Lithodendron*, *Axinura*, *Siphonodendron* (M'Coy), and *Acrocyathus* are stated in the 'Archives' to be synonyms, and to have been separated from the species with laterally united corallites only on account of their free or lax habit of growth (“qui sont tous synonymes, et qui n'avaient pour but que de séparer les espèces à polypiérites libres latéralement de celles dont les individus sont prismatiques et soudés,” p. 433). The comparison with *Lithostrotion* (Lhwyd and Fleming) will be confined therefore to *Lithodendron* (Phill.), the oldest of the branched genera, to *Stylastrea*?, *Columnaria* (Dana, not Goldf.), and *Nemaphyllum*, with remarks on one or two illustrative basaltiform fossils. Only the first of these genera possesses a prevailing branched mode of growth, the others having uniformly corallites which are closely aggregated. The corals forming the *Lithostrotion* of the 'Archives' are separable therefore into two portions, the first, or equivalents of *Lithodendron*, consisting of eleven species, and the second of eight; and they are arranged nearly in conformity with the prevailing habit of growth, though, in consequence of the views of the authors of the monograph, not in distinct sections.

* In the 'Introduction to the Memoirs on British Fossil Corals,' *Lithodendron* of Phillips is retained, but the *Lithodendron* of Schweigger is said not to be “an admissible genus,” p. lxxi.; see also Appendix A. p. 597 et seq., Geology of Russia, for earlier remarks, 1845.

With regard to the comprising in one genus of corals having free and united corallites, the 'Archives' contains the following remark:—"Nous nous sommes assurés, pour les polypiers présentant la même organisation que le *Lithostrotion striatum* de Fleming, que le degré de rapprochement et de soudure des individus est très-variable dans une même espèce et par conséquent ne saurait avoir une importance générique" (p. 433). Reference is then made to *Lithodendron* and the other branched genera above enumerated; and in support of the opinion just given, *Lithostr. Canadense* may be quoted, though it is the only species in which a branched and massive composition is directly mentioned. It is however said to be "tantôt en touffe subdendroïde, tantôt moitié dendroïde, moitié astréiforme, ou tout à fait massif, suivant les divers degrés de rapprochement des individus" (p. 433). From this statement it appears that that coral was liable to many variations of growth; and the corallites in the *Lithodendra* of Mr. Phillips are well known to be occasionally united with more or less flattened sides; but these conditions are only incidents of development. On the contrary, not one of the massive or asteriform species described in the monograph (p. 441 to p. 445) is shown to assume a partially branched habit. A variable growth marks moreover equally with an invariable one, important peculiarities in the polype, and may be rightly assumed as one valuable generic character. But it is not sufficient to state that corallites are partially or wholly united; the nature of the junction as well as the degree of structural blending should be detailed, so far as it can be ascertained; likewise the characters of lateral processes by which a connexion between more or less distant branches was effected. In *Lithostrotion Phillipsi* (Archives), the corallites are stated to be frequently united in little series by their sides, so as to call to mind somewhat the arrangement of *Halysites* (p. 439) or *Catenipora*; but Count Alex. von Keyserling*, who had described the coral, and referred it to *Lithod. fasciculatum* (Phillips), says they are united by short, often proliferous transverse tubes ("verbunden durch kurze, oft proliferirende Querröhren"); while in *Lithostr. Harmodites* (p. 440. pl. 15. figs. 1, 1a) and *L. concameratum* (p. 441) connecting tubes are mentioned; similar in the former species to those of *Syringopora*; and in *L. Stokesi* the union is effected by expansions issuing from transverse ridges ("bourelets," p. 440, pl. 20. f. 2). All the other species noticed in the 'Archives' are apparently destitute of such processes; and the junctions seem to have been accomplished either by simple contact or an extension of the cellular structure, which occurs immediately

* Reise in das Petschora-Land, pp. 170-171. tab. 3. fig. 2.

within the wall of the corallite. Sometimes contiguous branches in the *Lithodendra* of Mr. Phillips are not united, and can be separated without a fractured surface; but where a junction had taken place, the coalesced walls could not, in general, be severed without producing a scar on one or both of the stems. The corallites of *L. Canadense*, which had become prismatic by contact ("par rapprochement") are also stated to be often detachable by the hammer without breaking (p. 434). Mr. Phillips's fig. 14 (Geol. Yorks. pl. 2) of *Lithodendron irregulare* exhibits two instances of slightly distant branches being united by lateral developments; and polished transverse sections of apparently the same species gave many examples of the mode in which junctions had been formed among corallites very near each other, as well as in close contact. The latter showed along the line of junction a strong boundary-wall more or less flattened, and sometimes the adjacent cellular structure was slightly irregular. Where a small interval had existed, an outer extension of one of the corallites effected the union; and this elongation was wholly cellular, or similar to the portion of the stem from which it issued. The cells were as regularly formed and arranged as within the corallite; and there was no indication of a point, which might have become an axis, or the centre of an abdominal cavity. Moreover, no line of separation or partition-wall occurred between the extension and the body of the corallite; care being taken to guard against an inner circle of dissepiments; but at the junction with the other stem was a distinct wall, similar to that just noticed as existing in united contiguous surfaces. These lateral elongations were not regarded as incipient corallites, which had been impeded in their growth, for reasons given in the remarks on those productions. So far as observed, they, however, invariably issued from only one of the united branches, as if their development had depended upon some peculiar requirement in the polype: M. Milne-Edwards and M. J. Haime nevertheless state, that in *Lithostr.* (*Lithodendron*) *irregulare* the corallites, especially in the lower part, "portant des bourgeons dont beaucoup ont avorté et semblent s'être soudés aux polypières voisines" (Arch. p. 437). The nature of the processes above mentioned, and the conditions under which they were developed, as well as the extent to which their characters may have been influenced by direct contact in corallites, remain to be investigated and described. It is enough for the present inquiry to know, that they exist in certain species; and that in others, contiguous branches are often laterally united, and cannot under such circumstances be separated without fracture.

It is impossible from want of information to determine whether Lhwyd's fossil was separable with entire exteriors; and as Park-

inson does not allude to the state of his coral when prisms were detached, it is equally difficult to arrive at a satisfactory inference respecting the amount of preservation in parted corallites of Dr. Fleming's *Lithostr. striatum*. The cabinet of Mr. D. Sharpe contains, however, specimens of a basaltiform fossil from the carboniferous limestone of Kendal, which resembles Parkinson's figures 3, 6 (*Org. Rem. ii. pl. 5*) in external configuration: rough transverse sections displayed also a "web-formed star" with traces of a central projection; and longitudinal sections exhibited "a plumose appearance" (consult *op. cit.* p. 44)—all of them farther points of agreement. The corallites separated easily, and the parted facets were entirely free from scars or other indications of fracture; while in one specimen they presented a continuous, opaque white layer of a friable nature, but which, when viewed with a proper light, exhibited faintly longitudinal ribs, and more or less distinctly transverse rugosities; also minute thread-like transverse lines ranging the whole breadth of the facet and marking, it is believed, increments of growth; while not a vestige was visible of the minute cellular composition which occurs immediately within the wall, and is very conspicuous in purposely abraded or fractured surfaces. This opaque, white layer evidently represented the original coral-matter, but in a friable state, probably from the abstraction of the animal portion; nevertheless as it occurred equally on each of the parted surfaces, it was inferred, that adjacent corallites are separable without fracture or the destruction of the minor structures. The detected characters moreover prevailed throughout the height ($2\frac{3}{4}$ inches) as well as breadth ($2\frac{1}{4}$ inches) of the specimen; and they therefore precluded, to that extent, the assumption of a local or periodical union. One specimen more completely occupied by calcareous spar had lost, to a great extent, the layer, but between the longitudinal striæ remnants of it existed, traversed by the supposed lines of increment; and where the wall had been nearly or entirely removed the internal or cellular composition was visible, but without the slightest indication of fracture. A basaltiform coral from Gower (South Wales), also in Mr. Sharpe's series of carboniferous fossils, presented characters similar to those of the last specimen; but some of the facets had been wholly deprived of their original investment, yet without fracture; and they displayed fully the cellular structure, or an irregular, white reticulation with meshes of dark carbonate of lime—the laminæ of the network agreeing in colour and substance with the walls above mentioned. It may be added, that the transverse lines of the reticulation had limited ranges, and that adjacent portions were on different levels; they were consequently quite dissimilar in character from the minute thread-like

lines of the investing layer. The *Nemaphyllum* of Prof. M'Coy needs no remarks under this head, the corallites being described as inseparable (*op. cit.* p. 15). The author is unable from want of means to extend this portion of the inquiry into the characters of English basaltiform corals; but the Russian fossil to which he applied the term *Stylastrea inconferta* (Geol. Russia, App. A. p. 621-622) presented exteriors resembling those just mentioned; though he is not aware that *Styl. irregularis* (M'Coy, *op. cit.* p. 9) has similar minor structures. Lastly, as respects this character, Mr. Dana states, that his *Columnariae* break into columns, without however mentioning the exterior condition of the parted corallites. A comparison of the limited materials thus brought under the reader's attention will afford the following points of difference as respects the connexion in branched and massive or asteriform species of *Lithostrotion* (Archives). In the former, juxtaposition, as before stated, is an occasional condition, and where a junction takes place, whether by processes or contact, a separation produces a fractured surface: on the contrary, in the massive species examined the corallites were uniformly contiguous; and when parted, they did not exhibit a disrupted, but a perfect exterior, as well as the minute lines of increment; while in specimens which had lost the coral matter during mineralization, or had been otherwise deprived of it, there was an equal absence of fracture—the exposed facets in the one case displaying casts of the original structures; and in the other, a smooth surface with an unbroken reticulation.

The precise mode in which additional corallites were produced in *Lithodendra* or branched species of *Lithostrotion*, the author believes, has not been described; and he is able to give but imperfect notices of early states in only two, referable he conceives to *Lithod. irregulare* and *L. sexdecimale* (Phillips). Polished transverse sections of the former afforded two examples of incipient branches. One of them, and probably the younger, presented a lateral semicircular projection, about half the diameter of the parent stem. The straight side, or that in contact with the old corallite, was situated within the substance of the latter, but was separated from it by a strong partition-wall—a fine, more opaque line defining the boundary beyond the two bodies; while the curved portion protruded markedly beyond the periphery of the old branch, and had its own white wall. The minute area thus circumscribed was occupied principally by lamellæ-like plates, two or three of which ranged directly across it, or from the straight to the curved side; but the others had a more irregular outline, and were forked or connected by transverse laminae. There was however no convergence to a centre; nor any medial point indicative of an axis; the plates bearing more the semblance

of continued, previous lamellæ, than those which are originated in germs. It was impossible to consider this development, with its free semicircular outline and bold wall towards the parent stem, as a condition of the cellular extensions before mentioned, and in which, as already stated, no dividing structure exists: the composition also of the one differs wholly from that of the other. The second example of an addition in *L. irregulare* agreed in position, outline, and the existence of a perfectly enviroing layer with the first; but the structure within its area was not so distinct. Nevertheless, in the middle was a white spindle-shaped spot, possibly an incipient axis; and from the wall, on the straight side as well as the curved, issued rudimentary plates. No doubt was entertained that both these bodies were young corallites; and from the internal characters of the former, it was inferred that they were not strictly produced from germs, but contained within them partial extensions of structures which had entered into the composition of the parent. No instance was detected of a very early state in offshoots of *Lithod. sexdecimale*, but several of a more advanced stage. They were all smaller than the stems to which they were attached; and they had on that side a well-formed straight or curved wall, the concave outline of the latter being adapted to the convex exterior of the old corallite. They had more or less the contour of a horse-shoe, in consequence of oblique intersections; and around the wall were rudimentary lamellæ, the more prominent plates being generally on the side most distant from the parent stem. Other states farther advanced towards maturity were observed in both species; but they did not require special notice. A direct comparison between the reproductive process above imperfectly noticed, and that in the fossils of Lhwyd and Parkinson, or in the *Lithostrotion striatum* of Dr. Fleming and the *Cyathophyllum basaltiforme* of Mr. Phillips, cannot be established from want of information; nor was the mode detected in the basaltiform corals included in Mr. Sharpe's collection. The author is also unable to test the accuracy of his statement respecting the plan in *Stylastrea*, and regarding which the 'Archives' contains the following observation: "La prétendue multiplication par fission signalée par M. Lonsdale, et qui a servi à cet auteur de caractère pour séparer cette espèce des *Lithostrotion*, nous semble être le résultat d'une mauvaise observation." (*Lith. ? inconfertum*, p. 445.) He regrets that the grounds for correcting his error are not given; and he only conjectures, that what he believed to be a fissionary operation, may be regarded by M. Milne-Edwards and M. Jules Haime as due to submarginal, gemmiferous developments. He ventures nevertheless to copy his account of what he noticed, and principally in the Russian coral to which he applied the term

*Styl. inconferta**, that the reader may form his own opinion respecting it, and be able to compare the statement with the characters assigned to young branches in *Lithod. irregulare* and *L. sexdecimale*. "The additional columns were produced by a subdivision parallel to one of the facets of the pre-existing column, and not by the development of a circular germ. Externally the partition was rendered visible by a line commencing in outer walls on opposite sides of a column, and ranging upwards, it almost immediately marked a clear boundary between two distinct columns." * * * * "In a section purposely made about half a line below the point where a subdivision was visible, the transverse under surface exhibited not the least sign of any irregularity in the lamellæ or in the interstitial plates. The young or offset column, which commenced immediately above the section (fig. 2 b), nearly subdivided the facets from which it sprung; but its area was much less than half that of the pre-existing column." * * * * "The structure exhibited in this uneven plane" (the obliquely fractured, upper surface of the young corallite, fig. 2 b, pl. A. *op. cit.*) "was much less regular than that in the section beneath, though not very different from the arrangement of the component laminae near the sides of other columns in which no subdivisions existed: traces also of extensions upwards of the lamellæ of the undivided column were likewise detectable, indicating that the polype of the young column possessed, to a certain extent at least, the secreting membranes of the old."

From the foregoing statements respecting what had been observed in the reproductive processes of *Lithodendron* and *Stylastrea*, it is inferred, that additions were somewhat similarly effected in each case, or by an extension into the offspring of certain portions of the parent structures—that the operation was a modification of fissiparous productions—and that it should be carefully distinguished from purely gemmiferous developments.

The mode of increase in the *Columnaria* of Mr. Dana is not given in the description of the genus †. In *Nemaphyllum*, small circular buds were produced within the area of the parent star; and Prof. M'Coy's delineation exhibits the characters of a true germ. A marked difference therefore exists between the manner of effecting additions in that genus, and in *Lithodendron* or in *Stylastrea*.

As respects the internal composition of the fossils under consideration, the characters assigned in the 'Archives' to *Lithostrotion*, and before quoted, express very nearly the construction of the *Lithodendra* of Mr. Phillips, omitting the words "tantôt

* Geol. Russia, Appendix A. p. 620, commencing line 11, pl. A. fig. 2, 2 a-2 c.

† Exploring Expedition, Zoophytes, p. 362-363, 1846.

complètement soudés par leurs murailles" (Gen. Char. p. 432); provided the expression be rightly understood as applied to those species which are stated to be "massif" or "astréiforme." The existence of an axis is a point of agreement between the branched species (*Lithodendra*, Phillips) and certain of the massive. Mr. Phillips says, that his fossils have "a prominent central umbo or axis, generally oval in the section" (Geol. Yorks. ii. p. 202); while Dr. Fleming in his account of *Lithostr. striatum* mentions "a small, solid, central axis" (Brit. Anim. p. 508); and in the 'Archives' the only equivalent structure noticed among the generic characters is "une colonelle styliforme" (p. 432). Whatever may be the intimate composition of these bodies,—and it may be stated, that in *Lithod. irregulare*, or in closely allied species, the axis is not solid, but formed of laminæ,—they apparently agree in presenting a small continuous structure, which to the unassisted eye is nearly uniform in dimensions and compactness. It is uncertain whether the *Cyathophyllum basaltiforme* of Mr. Phillips, and identified by that authority as well as in the 'Archives' (p. 442) with *Lithostr. striatum*, has an umbo or axis; and a similar doubt exists respecting Parkinson's *Lithostrotion*, likewise considered in the 'Archives' (p. 441) as equivalent to Dr. Fleming's species. Should however the "prominent star, one-third of the diameter of the" (terminal) "concavity" be regarded as an axis, still the structural composition is markedly different from what is detectable in the umbo of *Lithodendra*. Allusion is made in a former paragraph to a basaltiform coral from the mountain limestone of Kendal, and among other resemblances visible in transverse, fractured surfaces, to the characters mentioned by Parkinson, traces of a swelling in the centre of the corallite are noticed. The direct middle of these projections sometimes exhibited an irregular white spot, or a thickened line formed by the union of opposite lamellæ; and the two structures, in specimens purposely worn down, passed into each other, and often vanished entirely, the absence being evidently not due to decay, but to an altered mode of union in the lamellæ. A vertical section through the centre gave a very narrow area, occupied by a minute reticulation consisting apparently of the edges of lamellæ with transverse dissepiments, and not by a compact persistent body. Again, in the Russian fossil, *Stylastrea inconfertata*, a styliform axis is manifestly wanting, not from decomposition, but from such a structure never having existed (consult Archives, p. 445, *Lithostrotion? inconfertum*). Prof. M'Coy in his description of a British species, *Stylast. irregularis*, also makes no allusion to an axis; on the contrary, he says, the centre of his fossil "is remarkable for the nearly perfect transverse chambering" (Ann. and Mag. of Nat. Hist. 2nd Ser. vol. iii. p. 9). The

centre of the fossils composing the *Columnaria* of Mr. Dana "consists of oblique septa and cellules converging upwards into an axis;" and it is further said, that "this axis appears to be made by a convolution of the septa or their partial coalescence" (*op. cit.* p. 363; see also pl. 26. figs. 9b & 10). Between this structure and the solid axis of Dr. Fleming or of Mr. Phillips's *Lithodendra*, there is no resemblance. *Nemaphyllum* has however "a straight, thin, flat, fillet-like solid, or nearly solid axis" (*op. cit.* p. 15), which might readily be considered as only a modification of the structure in *Lithodendra* and *Lithostr. striatum*; but an agreement in this particular does not by itself warrant a generic union.

From these statements it appears, that among the fossils included in the *Lithostrotion* of the 'Archives,' some, as the species originally described by Mr. Phillips (*Lithodendra*), the *Lithostr. striatum* of Dr. Fleming, and the *Nemaphyllum* of Prof. M'Coy, have a "solid" or an apparently compact axis; while Parkinson's fossil and the supposed Kendal equivalent, also the *Columnaria* of Mr. Dana, have a large central projection of lax composition; and in *Stylastrea* as well as in *Cyathophyllum basaltiforme*, the existence of an axis cannot be affirmed. An agreement, as before mentioned, occurs therefore in certain branched and one massive or basaltiform species, omitting *Nemaphyllum* on account of its inseparable corallites; nevertheless the accordance does not constitute a generic identity even in the fossils in which it exists.

The next structure claiming attention is that which surrounds the axis. Mr. Phillips does not describe its composition; but his delineations of vertical sections (*op. cit.* pl. 2. fig. 17 & 19), possibly intended only as diagrams, exhibit simple laminæ inclined upwards and resting against the axis; though in the specimens examined they were often complex; occupying, however, as in the figures just quoted, a broad band on each side of the slender central body. In the 'Archives' the "visceral chambers" are stated to present "dans leurs parties centrales des planchers bien développés, qui sont traversés par une columelle styliforme" (p. 432). The transverse sections which were examined afforded diversity of character, according to their position with respect to the upturned laminæ. Sometimes the axis was surrounded by a clouded, ill-defined band, marking apparently a coincidence in the plane of cutting with the surface of one of those laminæ; occasionally an open zone occurred traversed by irregular, curved lines; and not unfrequently lamellæ ranged up to the axis. The equivalent portion of Lhwyd's coral is unknown; and Dr. Fleming in his account of *Lithostr. striatum* simply mentions the union of "the rays of the star" with a small solid axis—only one of the conditions in *Lithodendra*. The central projection in

Parkinson's *Lithostrotion* and in the Kendal fossil will possibly be regarded by most observers as an axis, in which case, as respects at least the latter, the zone under consideration will not exist. Regarding *Cyath. basaltiforme* no opinion can be hazarded whether it has a representative of this intermediate area; but in *Stylastrea*, if the transverse laminæ be considered an equivalent structure, then there is no axis. One of Mr. Dana's delineations of *Columnaria* indicates on each side of the central composition a narrow band (*op. cit.* pl. 26. fig. 9*b*), which however becomes evanescent in the upper part of the figure; and his other vertical section (fig. 10) gives no analogous zone; while, according to the following extract from the generic description, he possibly did not consider that an intermediate band exists—"Corallum having the cells radiate, the middle within consisting of oblique septa and cellules converging upwards into an axis; texture exterior to the middle portion, cellular" (p. 363). *Nemaphyllum*, on the contrary, has an intermediate zone, or "a sharply defined cylinder of very minutely vesicular arched plates, the rows directed from the axis obliquely downwards and outwards;" and the illustrative woodcut expresses very nearly what is sometimes visible in the equivalent portion of *Lithodendra*. In that genus however, so far as is known, the zone is not "a sharply defined cylinder," and the circle occasionally shown in transversely cut corallites is an intersected upward-inclined plate; and not part of a continuous, vertical lamina as in Prof. M'Coy's figure (*op. cit.* p. 15). This will most probably be regarded by many palæontologists as an unimportant distinction, nor is it advanced as a valid generic difference by itself; but when taken in conjunction with the mode of reproduction, and the inseparable union of the stems, it forms one of a series of dissimilarities.

With reference to the agreements or otherwise in this portion of the *Lithostrotion* of the 'Archives,' it appears, that in the branched fossils referable to Mr. Phillips's *Lithodendra*, there is a large intermediate area of somewhat variable character, but essentially composed of curved laminæ inclined upwards and centrally—that in Lhwyd's fossil, Dr. Fleming's *Lithostr. striatum* and *Cyath. basaltiforme*, there is no authority for assuming its existence—that in Parkinson's *Lithostrotion*, also in the Kendal coral, and possibly in Mr. Dana's *Columnaria*, it is wanting, if the complicated central laminæ be regarded as an axis—and that in *Stylastrea* provided the transverse plates be an equivalent, there is no axis; while in *Nemaphyllum* an analogous zone is present, but in conjunction with other peculiar characters. Hence it may be inferred, that there is no prevalent agreement in this particular between branched and massive or asteriform species; and even in Lhwyd's *Lithostrotion* or Dr. Fleming's *L.*

striatum, the very existence of the most prominent part of *Lithodendra* remains to be ascertained.

The outer zone is simply stated in the 'Archives' to consist of "des traverses vésiculaires" (Gen. Char. p. 432); and Mr. Phillips's figures 12, 13, 15, 16 and 20, also 17 and 19, exhibit a narrow band similarly constituted, though each delineation varies somewhat in character. A specimen which afforded many transverse sections of a species probably referable to *L. fasciculatum* (Phill. pl. 2. figs. 16, 17) gave two conditions of this zone—one which presented simply alternations of very broad and very narrow lamellæ; while the other had equivalent plates connected by a more or less regular circle of arched plates, the narrow lamellæ projecting just beyond it, as in figure 16 (Phillips), or a series of somewhat quadrangular cells was interposed between the wall of the corallite and the circle. A polished slab thickly beset with transverse and oblique intersections of apparently *Lithod. sexdecimale* yielded a few examples almost as regularly constructed as in figures 12 and 13 (Phillips)—the characters being either a simple series of broad lamellæ united by a circle of diaphragms and forming a single circle of cells (fig. 12), or analogous cells indented by rudimentary lamellæ (fig. 13). The sections gave, however, very generally much less uniformity; and in oblique cuttings there was necessarily a total want of symmetry. The outer zone of the fossil which was believed to be *Lithod. irregulare* (Phill. figs. 14 and 15) had a similar composition, or a row of small cells adjacent to the boundary-wall, and a large inner series as shown in figure 15 just quoted; but in the specimens examined, care was necessary to reduce the exhibited structures to that type; and the arrangement was even then detectable only in the most directly transverse sections. The breadth of the zone was limited in all cases, but greatest in *L. irregulare*; and in some vertically cut corallites it was occasionally almost wanting. No opinion can be formed respecting the existence of a similar outer area in Lhwyd's fossil or in Dr. Fleming's *Lithostr. striatum*. Parkinson says that transverse sections of his coral resemble a spider's web, displaying "numerous and exceedingly slender longitudinal lamellæ corresponding with the external striæ," and "disposed perpendicularly from the circumference to the centre in a stellated form;" also "proportionally numerous and equally delicate lamellæ perpendicularly disposed nearly in concentric circles" (Org. Rem. ii. p. 44); and his figure 3 (pl. 5) displays exactly such a structure. No data however are given whereby the interior of the corallites can be separated into areas, except that the prominent star may constitute one, and all exterior to it another. Mr. Sharpe's Kendal fossil conjecturally associated with Parkinson's coral had also numerous delicate lamellæ, half

of which, or every alternate plate, ranged to the centre, not in a straight line, but more or less waved; and the intermediate lamellæ stopt at what was supposed to have been the boundary of the central swelling. The dissepiments were likewise very numerous in the outer portion of the corallite, though not reducible to circles, being extremely irregular in position, distance and outline; while in the supposed axial area they were much fewer. The breadth of the outer zone was about half that of the semidiameter of the corallite. In *Cyathophyllum basaltiforme* two portions probably exist, as "the marginal lamellæ" are said to "commence within a thin, crenulated, vertical dissepiment," and judging by the illustrative figures 21 and 22, the width of the areas is similar to that in the Kendal fossil. The outer part of *Columnaria* is "cellular," and its breadth bears to the inner the proportions just mentioned; equivalent characters as well as measurements occur also in *Nemaphyllum*. Lastly, in *Stylastrea* the outer zone is largely cellular, the lamellæ and dissepiments being distant, but the dimensions agree with those in the other basaltiform fossils.

A comparison of the characters just enumerated in the exterior area of branched and massive species of *Lithostrotion* (Archives), so far as they are known in the latter, and in apparently allied fossils, will give the following differences:—in Mr. Phillips's fossils the structures are reducible generally to one type—a series of small cells adjacent to the walls, and another within of larger dimensions, the two being separated more or less prominently by a circle of arched plates; and the breadth of the area is small, sometimes almost inconspicuous: on the contrary, in the massive corals the cells cannot be brought to a definite arrangement or shape, except in Parkinson's fossil, according to its description, and in that case there is no distinction between the cells next the wall and those situated elsewhere; the breadth of the area is also relatively great in every case, equalling almost uniformly half the semidiameter of the corallites.

Little can be said respecting the lamellæ, and that little is given chiefly to excite inquiry. In the 'Archives' they are stated to be pretty well developed—"cloisons assez bien développées;" and in the 'Geology of Yorkshire' to be "generally twisted or extinct near the centre." The latter characters were fully exhibited in the specimens examined during the present inquiry; but nothing is believed to have been published respecting the want of vertical persistence in the inner area; though such a condition is intimated in the remark, that the lamellæ are sometimes twisted near the centre, and sometimes extinct, as if the extension had depended on variations in growth. No evidence wholly satisfactory respecting this point has been obtained; nevertheless

in longitudinal sections of the coral, believed to be *Lithod. fasciculatum*, some of the intervals between the inclined laminae of the inner area were not wholly traversed by lamellae, but presented a structure somewhat analogous to that given in the accompanying diagram. In the other species before mentioned no longitudinal sections were examined. Another particular in the lamellae of *Lithodendra*, requiring investigation, is the composition. According to the specimens of *L. fasciculatum* and *L. irregulare* which were examined, the opaque, white substance of the lamellae was traversed along the middle, in transverse sections, by a fine translucent line, resembling in colour the calcareous spar which filled the cells and other lacunae of the corallites. It was easily detected in the fossils considered identical with *Lithod. fasciculatum* and *L. irregulare*; occurring in the narrow plates as well as in the broad; but it was not discovered in *L. sexdecimale*. No lamellae vertically divided, as in *Stylastera*, were observed in a rough, partially fractured specimen of *L. irregulare*, though in polished, longitudinal sections of *L. fasciculatum* a translucent line often ranged down the middle of the vertical plates. The massive or basaltiform corals which were examined had in the inner area straight-edged lamellae; and in Mr. Dana's *Columnaria*, Parkinson's *Lithostrotion*, *Cyathophyllum basaltiforme* and *Nemaphyllum* the structure is probably similar. How far any of the latter corals have lamellae composed of two separable laminae remains to be ascertained.



These defective observations afford no data for satisfactory comparison, as they do not rest on clear structural evidence. It is however probable that the membranes from which the lamellae were produced had a periodical extension in one case, but not in the other; and in certain instances, as respects both branched and massive species, the lamellae were apparently biplated.

A survey of the characters noticed in the preceding paragraphs of this article will afford the following conclusions regarding the fossils which have been the subjects of consideration: 1st, the habit of growth, mode of union, and external condition of parted stems are dissimilar in *Lithodendra* (Phill.) and the basaltiform corals which were examined—omitting *Nemaphyllum* from the summary, as it is believed not to be truly columnar, and to be otherwise essentially different from the *Zoantharia* with which it is associated in the 'Archives'; 2ndly, additional corallites seem to have been produced in branched as well as massive species by equivalent processes, or by modified fissiparous operations, and not by simple germs; 3rdly, the internal structures vary in the number of the component parts to the extent to which they could be ascertained; and in the characters of each

part, or where an agreement exists in one particular, there are marked differences in others. Moreover not one of the massive species was so constituted, that it could be considered as possessing only specific modifications of the structures observed in the branched; while all the corals assigned to *Lithodendron* by Mr. Phillips have a unity of composition with subordinate differences; and among the massive *Zoantharia* some, at least, have also an aggregate of characters, but different from that of *Lithodendron*. Whatever value may be attached to these distinctions by some, the author conceives that they justify the retention of Mr. Phillips's genus—that as respects Lhwyd's fossil, there is a want of that amount of information which would warrant its being adopted as the basis of a genus—and that he was correct in limiting the term *Lithostrotion* to Dr. Fleming's second species, *L. floriforme*.

The author is unable to review each of the nineteen species described in the 'Archives'; but, that the reader may not have to rest on generic characters only, he begs to offer a few remarks on "*Lithostrotion basaltiforme*," which is identified with Lhwyd and Parkinson's fossils as well as with Dr. Fleming's *Lithostr. striatum*. The following are the assigned synonyms and characters (*op. cit.* p. 441-442).

1. *Lithostrotion*, Lhwyd, Lithophyl. Brit. Ichnog. tab. 23.
2. —————, Parkinson, Organic Remains, vol. ii. pl. 5. fig. 3, 6.
3. *Astrea basaltiformis*, W. D. Conybeare and W. Phillips, Outlines Geol. England and Wales.
4. *Astrea arachnoïdes*, De France, Dict. Sc. Nat. t. xlii.
5. *Lithostrotion striatum*, Fleming, British Animals.
6. *Columnaria striata*, De Blainville, Dict. Sc. Nat. t. lx.; Manuel d'Actinologie.
7. *Lithostrotion striatum*, S. Woodward, Synopt. Table, Brit. Org. Remains.
8. *Cyathophyllum basaltiforme*, Phillips, Geol. Yorkshire, t. ii. pl. 2. figs. 21, 22.
9. *Columnaria striata*, Milne-Edwards, Ann. de la 2^e édit. de Lamarck, t. ii.
10. *Astrea hexagona*, Portlock, Report on the Geology of Londonderry, pl. 23. fig. 1.
11. *Astrea basaltiformis*, *ibid.*
12. *Lithostrotion striatum*, M'Coy, Synop. Carb. Foss. of Ireland.
13. *Lithostrotion microphyllum*? Keyserling, Reise in das Peteschora-Land, tab. 1. fig. 2.
14. *Nemaphyllum minus*, M'Coy, Ann. and Mag. Nat. Hist. 2nd Ser. vol. iii.

“Polypier astréiforme. Polypières complètement soudés par leurs murailles et prismatiques; calices très-inégaux. Dans une coupe horizontale, on distingue des murailles extérieures, minces et très-nettes, et des murailles internes seulement indiquées par la limite des traverses vésiculaires qui emplissent les parties extérieures des loges; columelle petite, comprimée, mais un peu renflée au milieu; de 40 à 50 cloisons un peu serrées, extrêmement minces, très-finement flexueuses, alternativement un peu inégales; les grandes arrivant seules près de la columelle. Grande diagonale des grands calices 10, 12 ou même 15 millimètres (·39370, ·47244 and ·59055, or from more than $\frac{1}{3}$ to more than $\frac{1}{2}$ an inch); diamètre des murailles intérieures 5 ou 6 (·19685 and ·23622 of an inch).”

First as respects the altered specific name, adopted apparently from the ‘*Outlines*.’ The list of carboniferous corals, given in that work, includes the following announcement:—“*Astrea basaltiformis*. *Lithostroton*. Luid. t. 23, and three undescribed species” (*op. cit.* p. 359). It is however a rule that “a name which has never been clearly defined in some published work should be changed for the earliest name by which the object shall have been so defined* ;” yet in this case an undefined name has been substituted for one which had been defined, or *basaltiforme* for *striatum*. Moreover a reference in the ‘*Outlines*’ to Lhwyd cannot be regarded as a reference to a clear specific definition, or even to any definition, the terms employed being all applicable to more fossils than one and of different genera; and though Dr. Fleming’s characters are not so precise as the present state of knowledge requires, still they give a limitation which enables the reader to separate Parkinson’s fossil from *Lithostr. striatum*.

Before any general remarks are offered on the assigned specific characters and their amount of agreement with the generic, as well as with the fossils considered in the preceding list to be identical with Lhwyd and Fleming’s corals, it is thought advisable to notice separately the *Astrea arachnoïdes* of De France † (No. 4 of the list). In the ‘*Archives*’ reference is made only to the ‘*Dictionnaire des Sciences Naturelles*’; but De France in that work quotes Guettard’s ‘*Memoirs*’ (t. iii. p. 510. pl. 52. f. 2) and Parkinson’s ‘*Organic Remains*’ (vol. ii. pl. 5. f. 1. p. 40–41).

* Propositions for rendering the Nomenclature of Zoology uniform and permanent. Report British Association, 1842; also *Annals and Mag. Nat. Hist.* 1st Series, vol. xi. p. 266, 267, § 11 & 12.

† Not the *Astrea arachnoïdes* included in Lamarck, edit. 1836, t. ii. p. 420. No. † 43, a Maestricht fossil; nor the *A. arachnoïdes* of Fleming (*Brit. Anim.* p. 510), an oolite coral. (Parkinson, *Org. Rém.* vol. ii. p. 54, pl. 6. f. 4, quoted by Fleming.)

The figures there given have a general resemblance to each other, presenting an inner and an outer area; and they agree with Lhwyd's delineation in their numerous rays or lamellæ; but Guettard's fossil in the opinion of De France (*op. cit.* t. xlii. p. 384) had a centre or "axis*," which resisted the action of the weather, and gave rise to what Guettard terms "un couvercle" (Mem. t. iii. p. 510). This character would agree possibly with what Parkinson says respecting the centre of his *Lithostrotion* (Org. Rem. t. ii. p. 44), but not with Dr. Fleming's "small, solid, central axis" (Brit. Anim. p. 508), or with the "columelle styliforme" and "columelle petite" of the 'Archives' (Car. gén. p. 432; and Car. spec. p. 442); nor is such a structure exhibited in figure 2. pl. 52 (Mem.). In Parkinson's brief notice (Org. Rem. t. ii. p. 41) of the coral referred to by De France, no structural details are mentioned; but the figure (pl. 5. f. 1) was taken from a Swedish specimen, and the fossil is conjecturally identified with the Baltic fossil represented by Fougé †, and subsequently named by Linnæus ‡ *Madrepora ananas*—points which necessarily excite doubts respecting a specific agreement with Lhwyd's fossil. It is regretted that the data are not given for associating *Astrea arachnoïdes* with Lhwyd's *Lithostrotion* and Dr. Fleming's *L. striatum*; the remarks of De France and those of the authorities quoted by him being insufficient to satisfy an inquirer. Moreover the specimen from which the figure given in the 'Mémoires' and the accompanying explanation were derived, was obtained from Chaumont near Anvillers, three leagues from Verdun, a district believed to be geologically of the age of the oolites. It is possible however that the identification is with the smaller variety of Guettard's fossil mentioned only by De France, and found at Valogns (Manche) "dans les couches anciennes" (*op. cit.* p. 384). Nevertheless it would be satisfactory, had a note been given to fix the association with Guettard's original fossil or with De France's variety, as well as to define the locality and formation.

The chief distinction in the detailed specific and generic structures is the non-allusion in the former to central transverse laminae or "planchers bien développés" (Car. gén. p. 432); and

* "Ce morceau, dont la surface paroît avoir été détruite, présente, ainsi que le dit Guettard, un couvercle au milieu de chacune des étoiles; mais ce couvercle n'est autre chose qu'un axe, qui, ayant présenté plus de solidité que les rayons, se trouve élevé un peu au dessus d'eux."—Diet. Sc. Nat. t. xlii. p. 384. "Ce morceau" alludes to a specimen in De France's possession.

† Dissertatio de Coralliis Balticis apud Amœn. Acad. t. i. p. 195, and illustrative plate, figs. 9, 8. Parkinson quotes only fig. 8 and the diagram No. 2.

‡ Systema Naturæ, edit. 10. t. i. p. 797, No. 35.

it is believed that their absence is a true distinction between the branched species or *Lithodendra* and the massive corals enumerated among the synonyms of the preceding list, so far as their composition is known, with the exception of *Lithostrotion microphyllum* (No. 13) given with a doubt, and *Nemaphyllum minus* (No. 14); in both of which an intermediate zone of arched laminae exists similar to the plates in *Lithodendra*. It is also conceived, that the omission of the mode of increase in *Lithostr. basaltiforme* is correct, nothing being known respecting it in the fossils quoted as synonyms, except that in *L. microphyllum* (No. 13) new prisms were planted on the edges between the old corallites ("durch Einsenkung neuer Prismen in den Rändern zwischen den älteren"—Reise in das Petschora-Land, p. 156); and in the generic characters of *Nemaphyllum* (*N. minus*, No. 14), additions are stated to have been effected by "small circular buds developed within the area of the parent star" (Ann. and Mag. Nat. Hist. 2nd Ser. vol. iii. p. 15, and woodcut). The "columelle petite, comprimée, mais un peu renflée au milieu" (Archives, p. 442), agrees with the "columelle styloforme" of the generic characters (p. 432), and with the "small solid axis" of *Lithostr. striatum*; also to a certain extent with the central structure of *Nemaphyllum minus* (No. 14), and possibly with that of *Astrea hexagona* (No. 10); but there are no grounds for concluding that a similar axis occurs in Parkinson's *Lithostrotion* (No. 2), or in *Cyathophyllum basaltiforme* (No. 8), or perhaps in *Lithostr. microphyllum?* (No. 13). Again, the "polypierites" are said to be "complètement soudés par leurs murailles" (p. 442), by which the author understands that they are so united as to be inseparable with smooth exteriors. In the remarks on the mode of union, given in an early part of this communication, a want of positive information on this point is mentioned as respects the original fossils of Lhwyd (No. 1) and Parkinson (No. 2); though, from the facility with which the corallites in No. 2 separated (Org. Rem. t. ii. pp. 43, 44), it may be inferred that an intimate union did not exist. On the contrary, in *Astrea hexagona* (No. 10), *Lithostrotion microphyllum* (No. 13), and *Nemaphyllum minus* (No. 14), a perfect union is apparently maintained. Not one of the fossils included under the head *L. basaltiforme*, so far as is known from descriptions or delineations, ever assumes the branched habit of growth of *Lithodendra*.

Very little remains to be said. The fourteen quotations contained in the foregoing list include seven distinct fossils, which are numbered 1, 2, 4, 8, 10, 13 and 14, the remaining seven, Nos. 3, 5, 6, 7, 9, 11 and 12, being only references to Lhwyd, Parkinson and Phillips, without any increase of structural details except in the case of No. 5, Dr. Fleming's *L. striatum*. Of

